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BIOLOGY

0610/31

Paper 3 Theory (Core)

May/June 2020

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

1 (a) Fig. 1.1 shows some of the structures involved in excretion.

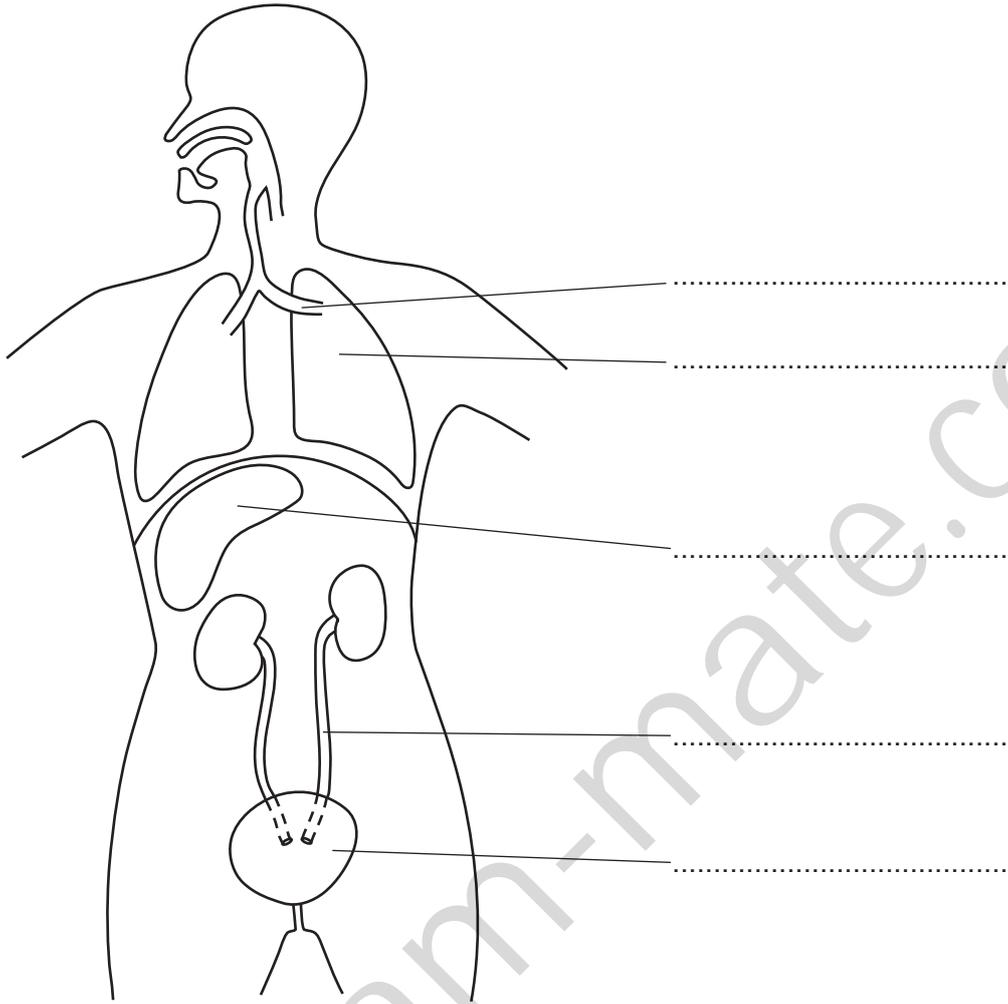


Fig. 1.1

Complete Fig. 1.1 by labelling the structures in the spaces provided.

Choose structures from the list:

- | | | | | |
|-----------------|-----------------|---------------|----------------|-------------|
| bladder | bronchus | heart | liver | lung |
| pancreas | trachea | ureter | urethra | |

[5]

(b) Urea is excreted.

(i) State the name of the substance that urea is made from.

..... [1]

(ii) State where in the body urea is made.

..... [1]

- (c) Urine produced by the kidneys contains three excretory substances: urea, water and mineral salts.

Table 1.1 shows the average mass of urea, water and mineral salts in 100g of blood plasma and in 100g of urine.

Table 1.1

substance	average mass/g	
	in 100g of blood plasma	in 100g of urine
water	90.00	95.00
urea	0.03	2.00
mineral salts	0.69	1.35

Calculate the percentage increase in the average mass of mineral salts between blood plasma and urine.

Give your answer to two decimal places.

Space for working.

..... %
[3]

- (d) Describe the process that produces the carbon dioxide that is excreted by the lungs.

.....
.....
.....
..... [2]

- (e) State the name of the component of blood that transports carbon dioxide to the lungs.

..... [1]

[Total: 13]

Question no. 1

(a) Labelling Fig. 1.1 [5 marks]

The diagram shows organs involved in **excretion**, including removal of carbon dioxide and urea.

Reading the arrows **from top to bottom**:

1. **Bronchus** – the branch of the trachea that carries air into the lungs.
 2. **Lung** – the organ where **carbon dioxide** is excreted from the blood during gas exchange.
 3. **Liver** – the organ responsible for **deamination** of excess amino acids and production of urea.
 4. **Ureter** – the tube that carries urine from the kidneys to the bladder.
 5. **Bladder** – the organ that **stores urine** before it is excreted from the body.
-

(b) Urea is excreted

(i) Substance urea is made from [1 mark]

Urea is made from **amino acids**.

(ii) Where urea is made [1 mark]

Urea is made in the **liver**.

(Excess amino acids cannot be stored, so they are deaminated in the liver.)

(c) Percentage increase in mineral salts [3 marks]

From Table 1.1:

- Mineral salts in blood plasma = **0.69 g**
- Mineral salts in urine = **1.35 g**

Step 1: Calculate the increase

Increase = $1.35 - 0.69$

Increase = **0.66 g**

Step 2: Calculate percentage increase

Percentage increase

= $(\text{increase} \div \text{original value}) \times 100$

= $(0.66 \div 0.69) \times 100$

= **95.65%**

Final answer:

Percentage increase in mineral salts = 95.65%

(d) Process producing carbon dioxide excreted by the lungs [2 marks]

Carbon dioxide is produced during **respiration**.

In **aerobic respiration**, oxygen is used to **break down glucose** (or other nutrient molecules) in cells to release energy.

Carbon dioxide is produced as a **waste product** of this process and is transported to the lungs to be excreted.

Word equation:

glucose + oxygen → carbon dioxide + water + energy

(e) Component of blood that transports carbon dioxide [1 mark]

Carbon dioxide is transported in the blood mainly in the **plasma**.

 **Marks covered**

- (a) 5/5
- (b)(i) 1/1
- (b)(ii) 1/1
- (c) 3/3
- (d) 2/2
- (e) 1/1

Total: 13/13 — full marks

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2 Fig. 2.1 shows an image of two sperm cells.

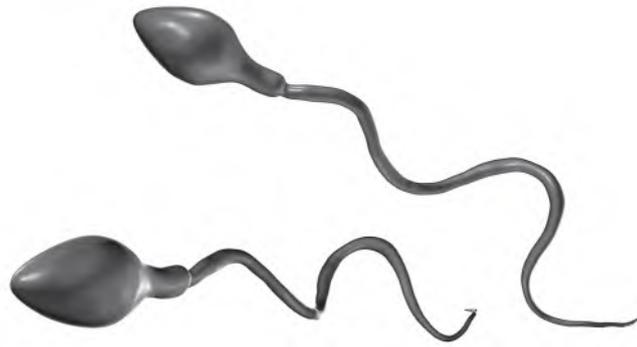


Fig. 2.1

(a) State **two** adaptive features of sperm.

1

.....

2

.....

[2]

(b) Describe the process of fertilisation.

.....

.....

.....

.....

[2]

(c) Fig. 2.2 shows a fetus during development.

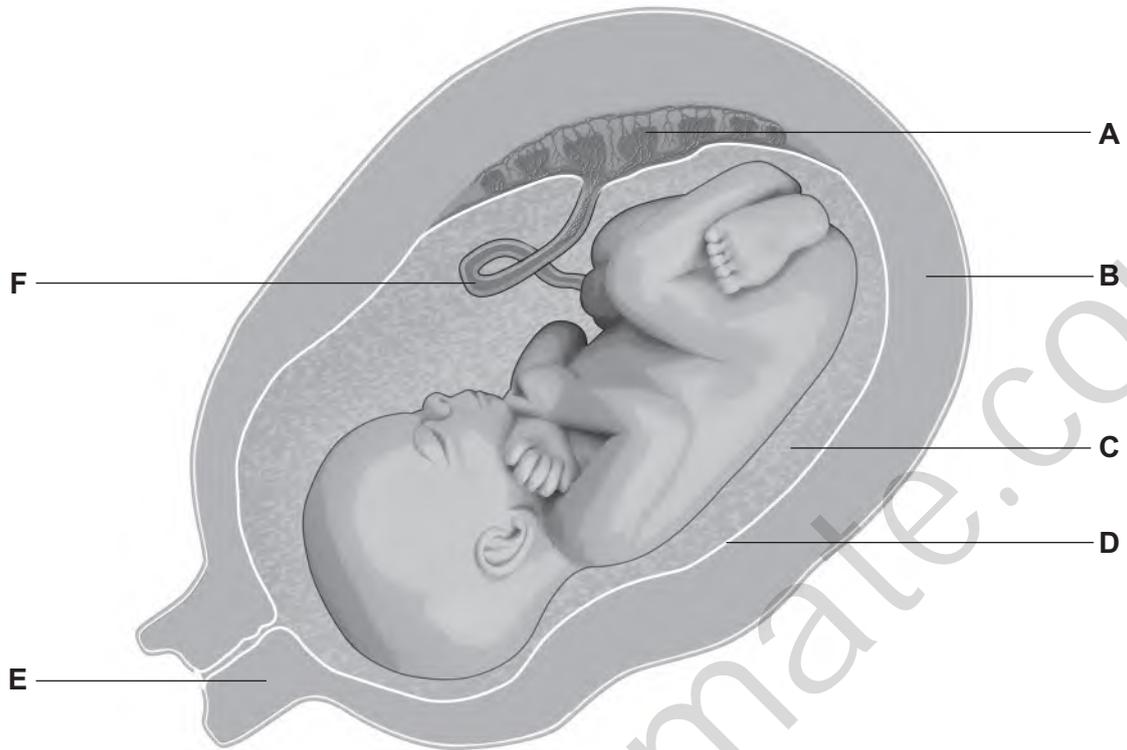


Fig. 2.2

Complete Table 2.1 by stating:

- the missing letters from Fig. 2.2
- the missing name of the structure
- **one** function for structures **C**, **A** and **F** during pregnancy or birth.

Table 2.1

letter on Fig. 2.2	name of the structure	one function
C	amniotic fluid	
		dilates during birth
A	placenta	
F	umbilical cord	
	uterus wall	contracts during birth

[6]

[Total: 10]

Question no. 2

(a) State two adaptive features of sperm. [2]

Sperm cells are highly specialised for fertilisation.

1. **A long flagellum (tail)** allows the sperm to **swim actively** through the female reproductive tract so that it can reach the egg.
2. **The acrosome contains enzymes** that are released to **digest the jelly coat / outer layers of the egg**, enabling the sperm to penetrate and fertilise it.

(b) Describe the process of fertilisation. [2]

Fertilisation is the fusion of a male and a female gamete. A sperm cell reaches the egg and releases **enzymes from the acrosome** that digest the egg's outer layers, allowing one sperm to enter. The **nucleus of the sperm fuses with the nucleus of the egg**, combining their genetic material to form a **diploid zygote**. Once one sperm has entered, changes occur in the egg's outer layer to **prevent any additional sperm from entering**.

(c) Complete Table 2.1 using Fig. 2.2. [6]

Completed Table 2.1

letter on Fig. 2.2	name of the structure	one function
C	amniotic fluid	Protects the fetus from mechanical damage (acts as a shock absorber)
E	cervix	Dilates during birth to allow the baby to pass out of the uterus
A	placenta	Supplies nutrients and oxygen to the fetus and removes waste products
F	umbilical cord	Transfers substances between the placenta and the fetus , such as oxygen, glucose, and urea
B	uterus wall	Contracts during birth to push the fetus out

3 Complete the sentences about genetic engineering.

Use words from the list.

Each word may be used once, more than once, or not at all.

adding **bacteria** **crops** **family** **insects**
minerals **organism** **removing** **viruses**
vitamin **weeds**

In genetic engineering the genetic material of an is changed by , changing or inserting individual genes.

An example of this is inserting a human gene into so that they produce human insulin.

Crop plants have genes inserted into them to make them resistant to herbicides.

Herbicides kill

Crop plants can also be genetically engineered by inserting a gene so that they produce a which is a nutrient needed by humans in very small amounts.

[5]

Question no. 3

Completed sentences with explanations

In **genetic engineering**, the genetic material of an **organism** is changed by **removing**, changing or inserting individual genes.

This sentence correctly uses **organism** because genetic engineering can be carried out on **any living thing**, such as plants, animals, or microorganisms. The word **removing** is correct because genetic engineering involves **taking out unwanted genes**, modifying existing genes, or inserting new ones.

An example of this is inserting a human gene into **bacteria** so that they produce human insulin.

Here, **bacteria** is the correct word because bacteria are commonly used in genetic engineering as they **reproduce quickly**, are easy to culture, and can be genetically modified to **produce useful human proteins**, such as insulin for treating diabetes.

Crop plants have genes inserted into them to make them resistant to herbicides. Herbicides kill **weeds**.

The correct word is **weeds** because herbicides are chemicals designed to **kill unwanted plants** that compete with crops for light, water, and minerals. Making crops resistant allows farmers to spray herbicides without damaging the crop itself.

Crop plants can also be genetically engineered by inserting a gene so that they produce a **vitamin**, which is a nutrient needed by humans in very small amounts.

The correct word here is **vitamin** because vitamins are **micronutrients** required in small quantities for normal growth and health. A well-known example is genetically engineered rice that produces **vitamin A** to help prevent deficiency.

Final answers (in order):

**organism
removing
bacteria
weeds
vitamin**

[5 marks] 

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4 Fig. 4.1 shows a photomicrograph of a cross-section of part of a leaf.

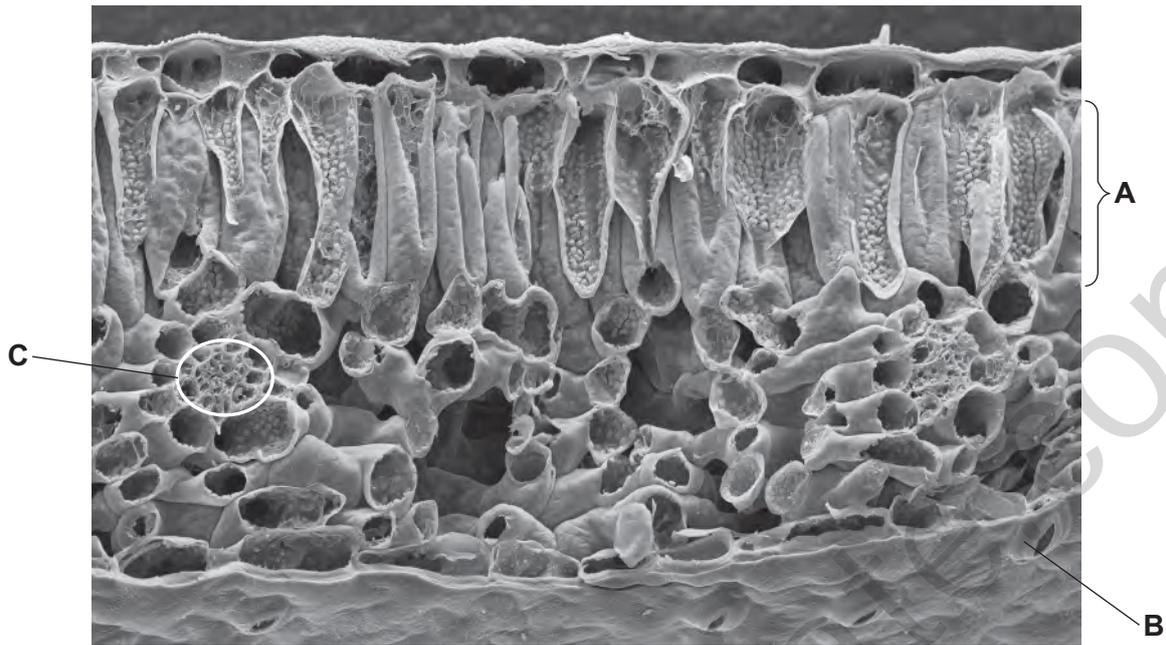


Fig. 4.1

(a) (i) Identify tissue **A** on Fig. 4.1 and state the name and function of this tissue.

name

function

[2]

(ii) Structure **C** in Fig. 4.1 is part of the transport system in the leaf.

State the names of **two** tissues that structure **C** contains.

1

2

[2]

(iii) Identify and state the name of cell **B** in Fig. 4.1.

..... [1]

(b) A plant is in bright sunlight and has plenty of water.

Gases move into and out of its leaves.

Complete Table 4.1 to show the net direction of movement for the named gases.

Place a tick (✓) in each correct box.

Table 4.1

name of gas	moves into leaves	moves out of leaves
carbon dioxide		
oxygen		
water vapour		

[3]

[Total: 8]

Question no. 4

(a)(i) Identification of tissue A and its function

Tissue A is the palisade mesophyll.

The palisade mesophyll is found just beneath the upper epidermis of the leaf and is made up of **long, tightly packed column-shaped cells**. These cells contain **a large number of chloroplasts**, which allows them to absorb as much light as possible.

The **function of the palisade mesophyll is photosynthesis**. This tissue is the main site where light energy is absorbed and converted into chemical energy, producing glucose from carbon dioxide and water.

(a)(ii) Tissues contained in structure C

Structure C is part of the vascular bundle, which forms the transport system in the leaf.

The two tissues contained within structure C are:

1. **Xylem** – transports **water and mineral ions** from the roots to the leaf.
 2. **Phloem** – transports **sucrose and other organic nutrients** away from the leaf to the rest of the plant.
-

(a)(iii) Identification of cell B

Cell B is a guard cell.

Guard cells surround a stoma and control its opening and closing, regulating **gas exchange** and **water loss** from the leaf.

(b) Net movement of gases in bright sunlight with plenty of water

The plant is in **bright sunlight**, so the **rate of photosynthesis is high**, and it also has **plenty of water**, meaning stomata are open.

Carbon dioxide

Carbon dioxide is used up during photosynthesis, so its concentration inside the leaf falls. As a result, **carbon dioxide diffuses into the leaf**.

✓ **Moves into leaves**

Oxygen

Oxygen is produced as a by-product of photosynthesis. Its concentration inside the leaf becomes higher than outside, so **oxygen diffuses out of the leaf**.

✓ **Moves out of leaves**

Water vapour

With stomata open and evaporation occurring from moist mesophyll cell surfaces, **water vapour diffuses out of the leaf** during transpiration.

✓ **Moves out of leaves**

Completed summary (in words)

- **Carbon dioxide** → moves **into** the leaf
- **Oxygen** → moves **out of** the leaf
- **Water vapour** → moves **out of** the leaf

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- 5 (a) Fig. 5.1 shows the average number of cigarettes smoked per day by male and female smokers between 1974 and 2014 in one country. Cigarettes contain tobacco.

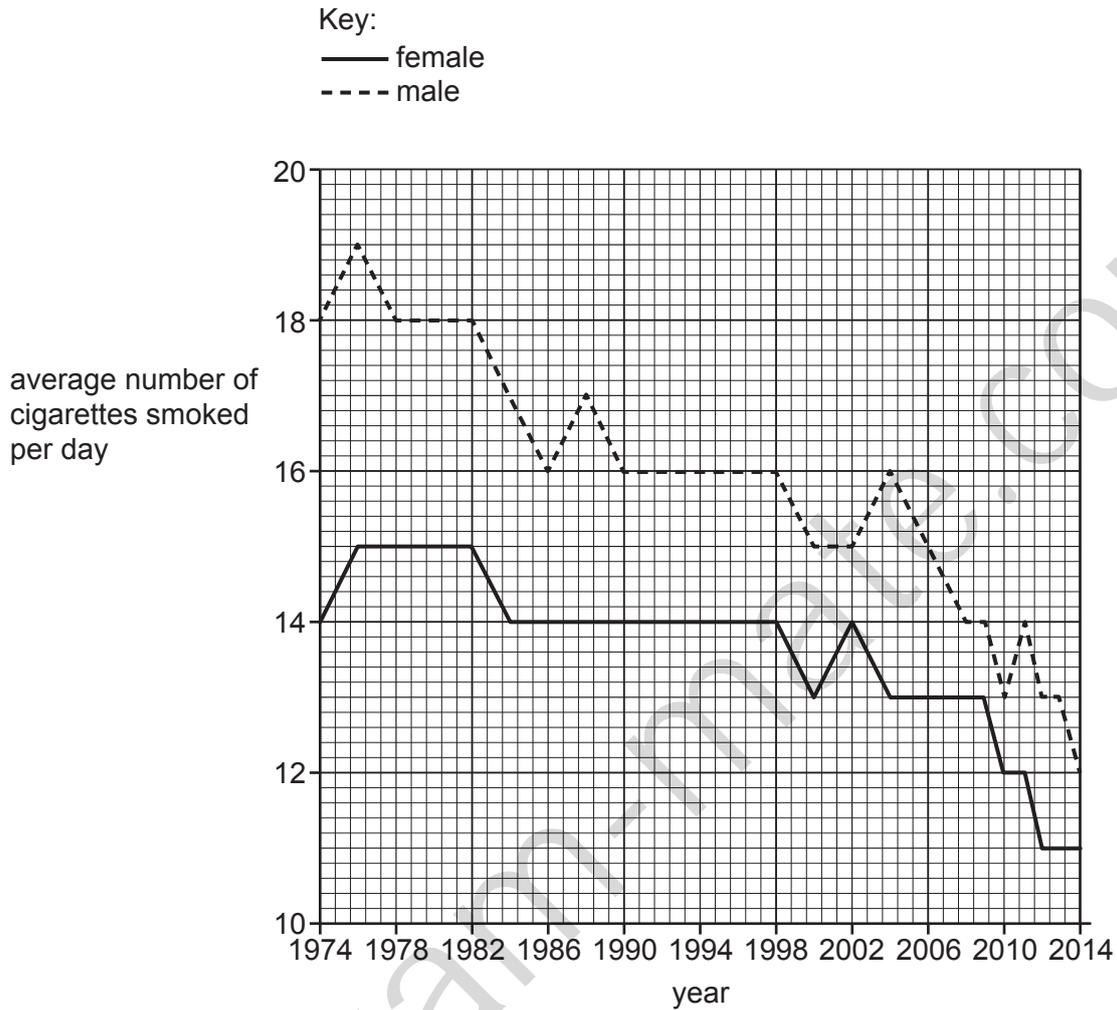


Fig. 5.1

- (i) State the average number of cigarettes smoked per day by female smokers in 1982.
 [1]
- (ii) State a year in which male smokers smoked an average of 19 cigarettes per day.
 [1]
- (iii) State **two** conclusions that can be made from the data shown in Fig. 5.1.
- 1
-
-
-
- 2
-
-
-

(b) Tar is a toxic component of tobacco smoke.

(i) State **two** effects of tar on the gas exchange system.

1

.....

2

.....

[2]

(ii) State the names of **two** toxic components of tobacco smoke other than tar.

1

2

[2]

(c) Describe **one** effect on the fetus of the mother smoking tobacco during pregnancy.

.....

.....

..... [1]

[Total: 9]

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Question no. 5

(a)

(i) **Average number of cigarettes smoked per day by female smokers in 1982**

From Fig. 5.1, the solid line represents **female smokers**.
At the year **1982**, the value on the y-axis corresponds to **15 cigarettes per day**.

Answer: 15 cigarettes per day

(ii) **A year in which male smokers smoked an average of 19 cigarettes per day**

The dashed line represents **male smokers**.
The graph shows a value of **19 cigarettes per day** in the mid-1970s. One correct year shown is **1976**.

Answer: 1976

(iii) **Two conclusions that can be made from the data in Fig. 5.1**

Conclusion 1:

Throughout the entire period shown, **male smokers consistently smoked more cigarettes per day than female smokers**. This is evident because the dashed (male) line remains above the solid (female) line in every year.

Conclusion 2:

The **average number of cigarettes smoked per day has decreased over time for both males and females**. In addition, the **decrease is greater for males than for females**, as the male values fall from around 19 cigarettes per day to about 12, whereas female values fall from about 15 to around 11.

(b)

(i) Two effects of tar on the gas exchange system

Effect 1:

Tar causes **paralysis of the cilia** lining the airways. This prevents the normal removal of mucus and trapped pathogens, leading to mucus build-up and increased risk of infection.

Effect 2:

Tar **deposits on the walls of the alveoli**, reducing the **surface area for gas exchange** and increasing the diffusion distance. This results in **reduced oxygen uptake** and can contribute to diseases such as **emphysema and chronic bronchitis (COPD)**.

(ii) Two toxic components of tobacco smoke other than tar

Component 1: Carbon monoxide

Component 2: Nicotine

(c)

One effect on the fetus of the mother smoking tobacco during pregnancy

Smoking during pregnancy reduces the amount of **oxygen delivered to the fetus**, mainly because carbon monoxide binds to haemoglobin. This can result in **low birth weight**, as the fetus does not receive sufficient oxygen for normal growth and development.

6 Fig. 6.1 shows images of cells from two different organ systems.

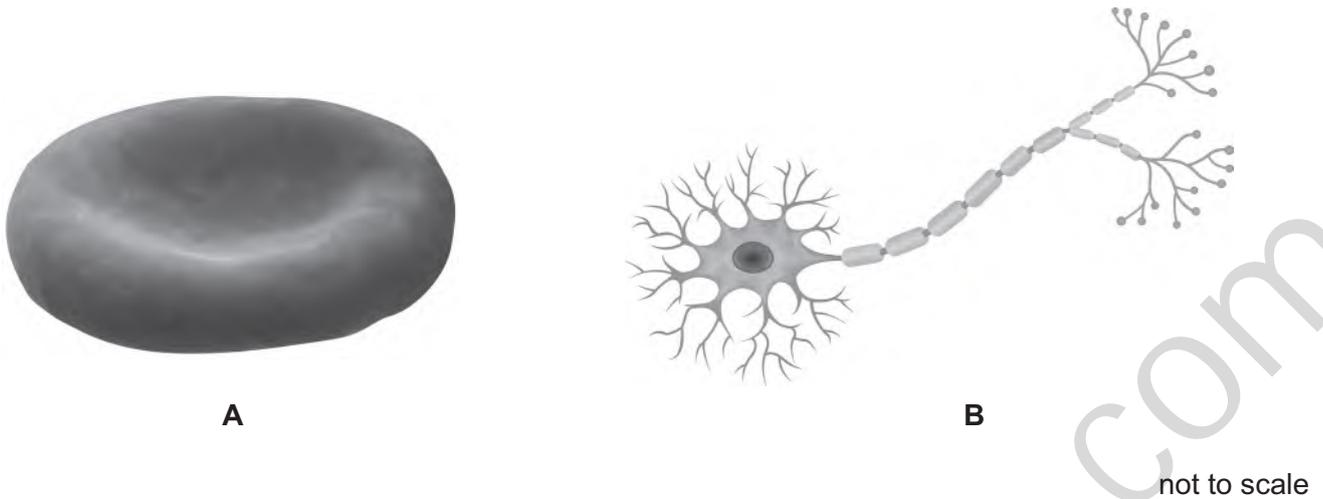


Fig. 6.1

(a) State the names of the cells shown in Fig. 6.1.

cell A

cell B

[2]

(b) Complete the definition of the term *tissue* by inserting the missing words.

A tissue is a group of cells with similar working together to perform a shared

[2]

(c) State the names of the organ systems these organs belong to.

brain

stamen

ovary

[3]

[Total: 7]

Question no. 6

(a) Names of the cells shown in Fig. 6.1

Cell A is a **red blood cell**.

This cell has a characteristic **biconcave disc shape**, which increases its surface area for efficient **oxygen transport** in the blood. It is specialised for carrying oxygen around the body as part of the circulatory system.

Cell B is a **neurone (nerve cell)**.

This cell has a **cell body with dendrites**, a long **axon**, and branching **axon terminals**, which are all adaptations that allow it to **transmit electrical impulses** rapidly over long distances.

(b) Definition of the term *tissue*

A **tissue** is a group of cells with similar **structure** working together to perform a shared **function**.

This means that the cells in a tissue are shaped and adapted in similar ways so that, collectively, they can carry out a specific job efficiently within an organism.

(c) Names of the organ systems these organs belong to

The **brain** belongs to the **nervous system**, which is responsible for coordination, control, and the transmission of nerve impulses throughout the body.

The **stamen** belongs to the **reproductive system** of a flowering plant. It is the male reproductive organ and is involved in the production of pollen.

The **ovary** also belongs to the **reproductive system**. In plants, it contains the ovules, which develop into seeds after fertilisation.

7 (a) Fig. 7.1 shows a tropical forest where the trees have been cut down.



Fig. 7.1

(i) State the name of the type of habitat destruction shown in Fig. 7.1.

..... [1]

(ii) Describe **two** reasons why humans destroy habitats such as tropical forests.

1

.....

2

..... [2]

(b) Fig. 7.2 is a graph showing the estimated area of trees that have been removed from tropical forests between 2001 and 2017.

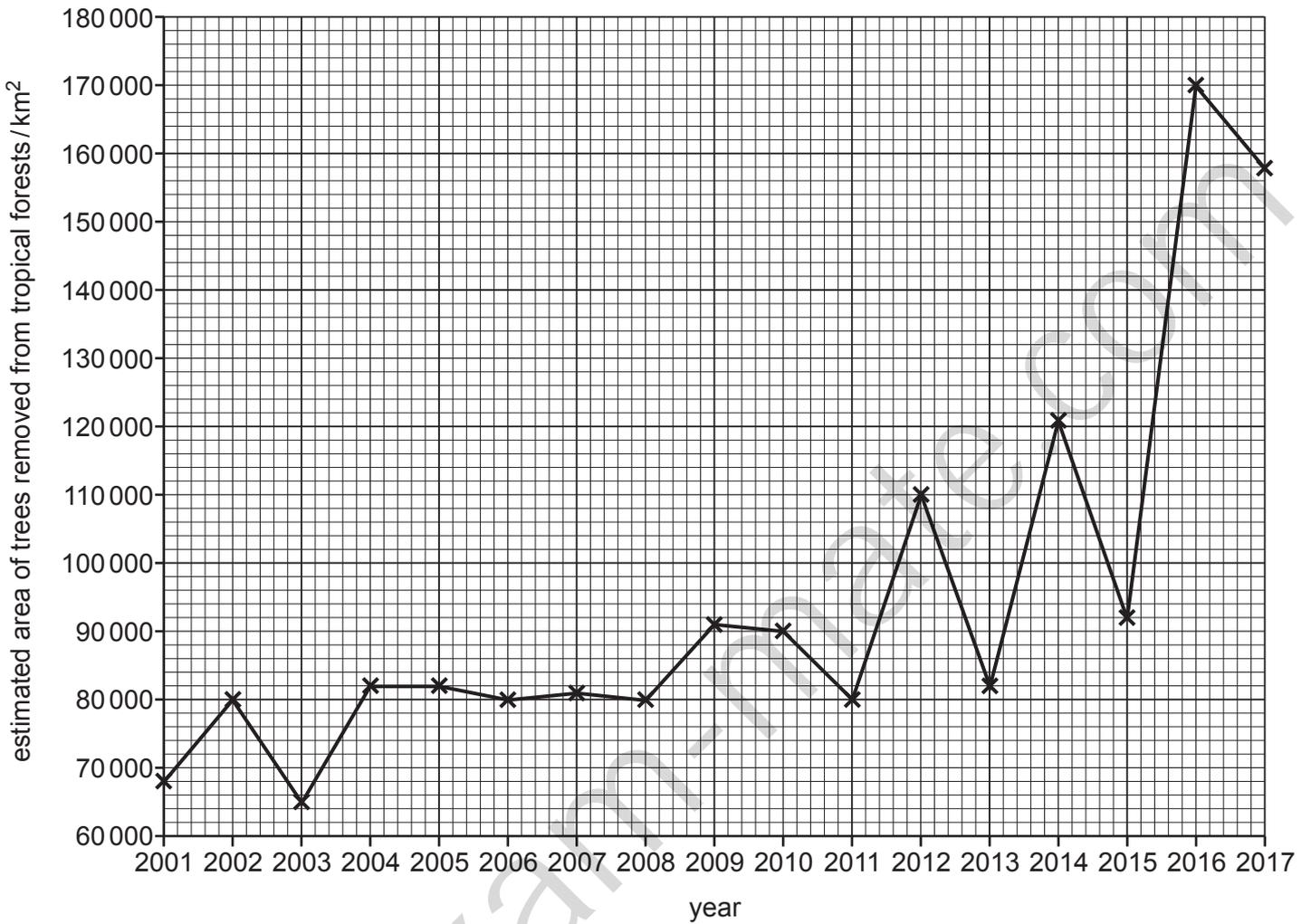


Fig. 7.2

(i) State the year which had the lowest estimated area of trees removed from tropical forests on Fig. 7.2.

..... [1]

(ii) State the area of trees removed in 2012 on Fig. 7.2.

..... km² [1]

(iii) A student made three statements about the data in Fig. 7.2:

- 1 The number of trees cut down increases every year.
- 2 The number of trees cut down in 2014 was three times more than the number of trees cut down in 2003.
- 3 Fewer trees were cut down in 2017 than in 2016.

Complete Table 7.1 by using the data in Fig. 7.2 to decide if each statement is true or false and state the evidence that supports your decision.

Table 7.1

statement number	true or false	evidence from Fig. 7.2
1
2
3

[3]

(c) Fig. 7.3 shows pollution in a marine environment and Fig. 7.4 shows pollution in a land environment.

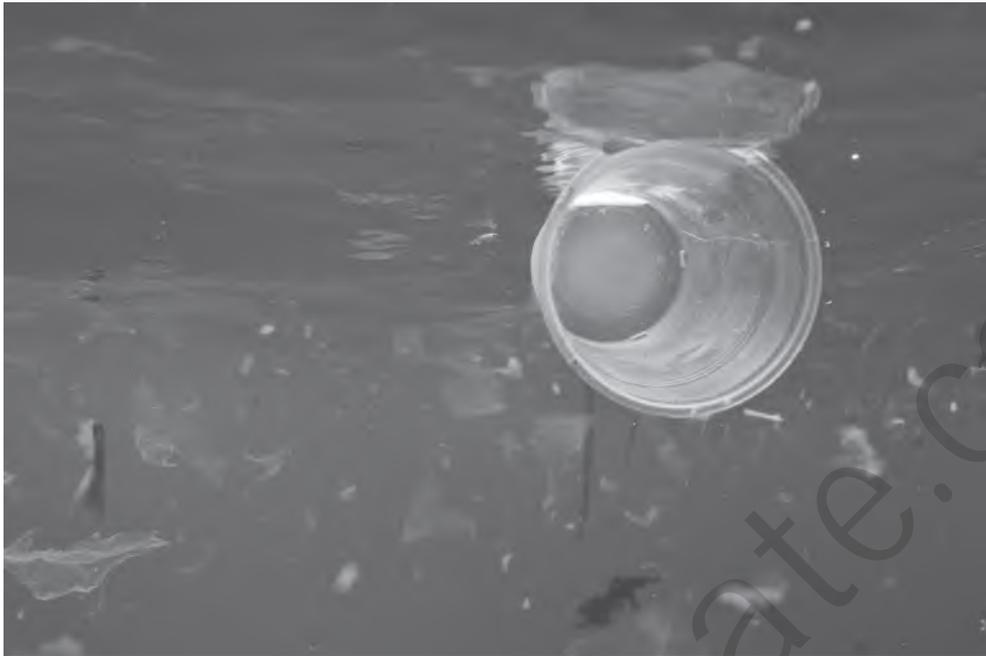


Fig. 7.3



Fig. 7.4

State the name of **one** source of pollution for each of the environments shown in Fig. 7.3 and Fig. 7.4.

marine

land

[2]

[Total: 10]

Question no. 7

(a)

(i) Name the type of habitat destruction shown in Fig. 7.1

This is **deforestation** (trees have been cut down and the forest habitat has been cleared).

(ii) Two reasons why humans destroy habitats such as tropical forests

Humans destroy tropical forests mainly to **use the land or resources for human needs**, for example:

1. **To create more land for agriculture**, such as **plant crop production** (clearing forest to grow crops).
2. **To extract natural resources**, e.g. **logging for timber** or **mining** (clearing vegetation to access valuable materials).

(Other valid reasons include **land for livestock farming** and **housing/urbanisation**.)

(b)

(i) Year with the lowest estimated area of trees removed (Fig. 7.2)

The lowest value occurs in **2003**.

(ii) Area of trees removed in 2012 (Fig. 7.2)

In **2012**, the estimated area removed is **110 000 km²**.

(iii) Table 7.1 (true/false with evidence)

Statement 1: "The number of trees cut down increases every year."

- **False**
- **Evidence:** The graph shows **decreases in some years**, e.g. it **drops from 2002 to 2003**, and also drops in other places such as **2012 to 2013** and **2014 to 2015**. So it does **not** increase every year.

Statement 2: "The number of trees cut down in 2014 was three times more than the number cut down in 2003."

- **False**
- **Evidence:** In **2003** it is about **65 000 km²** and in **2014** it is about **121 000 km²**. If 2014 were "three times" 2003, it would need to be **3 × 65 000 = 195 000 km²**, but **121 000 km² is much less than 195 000 km²** (so it is not three times).

Statement 3: "Fewer trees were cut down in 2017 than in 2016."

- **True**
 - **Evidence:** In **2016** it is about **170 000 km²**, while in **2017** it is about **158 000 km²**. Since **158 000 < 170 000**, fewer were cut down in 2017.
-

(c) One source of pollution for each environment

- **Marine (Fig. 7.3): Plastic waste** (e.g. plastic cups/bottles/bags entering the sea).
- **Land (Fig. 7.4): Agricultural chemicals** such as **pesticides / herbicides / fertilisers** being sprayed onto land (and potentially washed into soil and water).

8 (a) Fig. 8.1 is a diagram of a section of human skin.

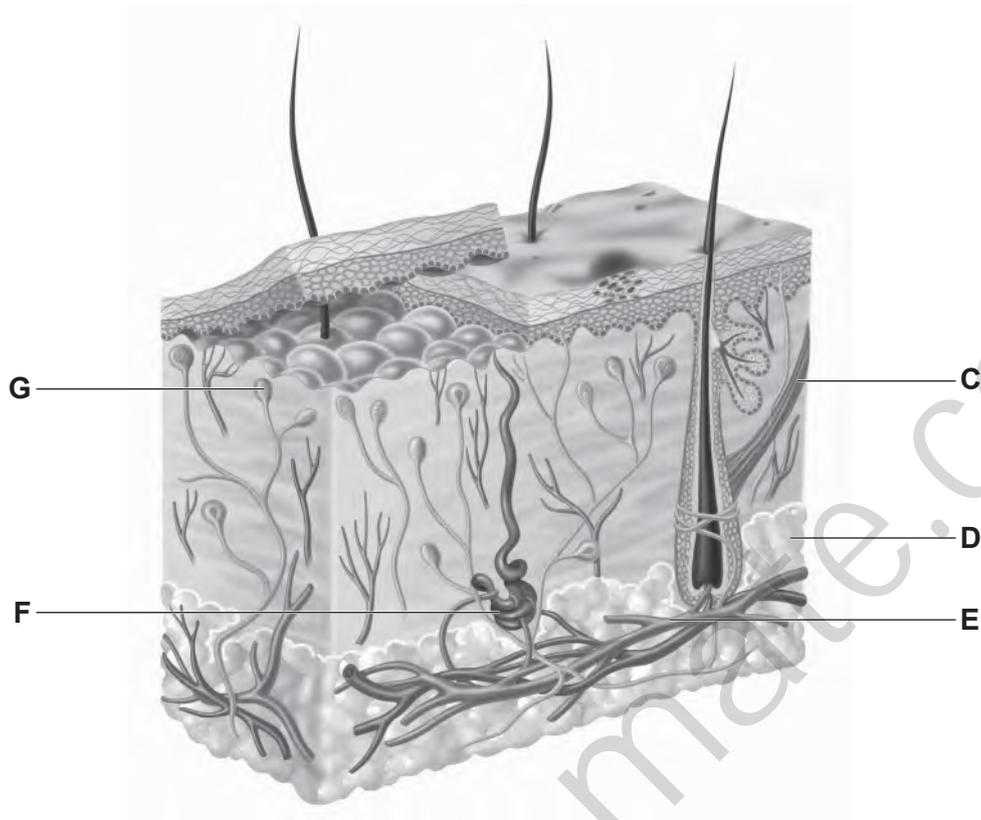


Fig. 8.1

State the names of the structures identified by the labels in Fig. 8.1.

- C
- D
- E
- F
- G

[5]

- (b) Complete the sentences about temperature control in humans by writing the missing words in the gaps.

If body temperature increases above normal, in the
..... detect the rise in temperature and impulses are sent to the skin.

Glands in the skin produce a liquid called The main component
of this liquid is water.

The water in the liquid from the surface of the skin using heat
energy from the body. This lowers the body temperature.

The maintenance of a constant body temperature is an example of
.....

[5]

[Total: 10]

Question no. 8

(a) Names of the labelled structures in Fig. 8.1

C – Erector muscle (hair erector muscle)

This is a small muscle attached to the hair follicle. When it contracts, it pulls the hair upright. This reduces heat loss by trapping a layer of insulating air next to the skin surface.

D – Fatty tissue (fat cells / adipose tissue)

This layer contains fat cells which act as **thermal insulation**, reducing heat loss from the body. It also provides energy storage and protection.

E – Blood vessel (small artery / small vein / capillary)

These blood vessels transport blood through the skin. They play an important role in temperature regulation by **vasodilation** (to lose heat) and **vasoconstriction** (to conserve heat).

F – Sweat gland

This gland produces sweat, which is released onto the surface of the skin through a duct. Sweat production increases when body temperature rises.

G – Sensory nerve ending (receptor)

These nerve endings detect changes in the environment, such as temperature or pressure, and send impulses to the nervous system.

(b) Temperature control in humans (completed sentences)

If body temperature increases above normal, **receptors** in the **brain** detect the rise in temperature and impulses are sent to the skin.

Glands in the skin produce a liquid called **sweat**. The main component of this liquid is water.

The water in the liquid **evaporates** from the surface of the skin using heat energy from the body. This lowers the body temperature.

The maintenance of a constant body temperature is an example of **homeostasis**.

9 The eye is an example of a sense organ.

(a) Define the term *sense organ*.

.....

 [2]

(b) Fig. 9.1 shows a section through the eye.

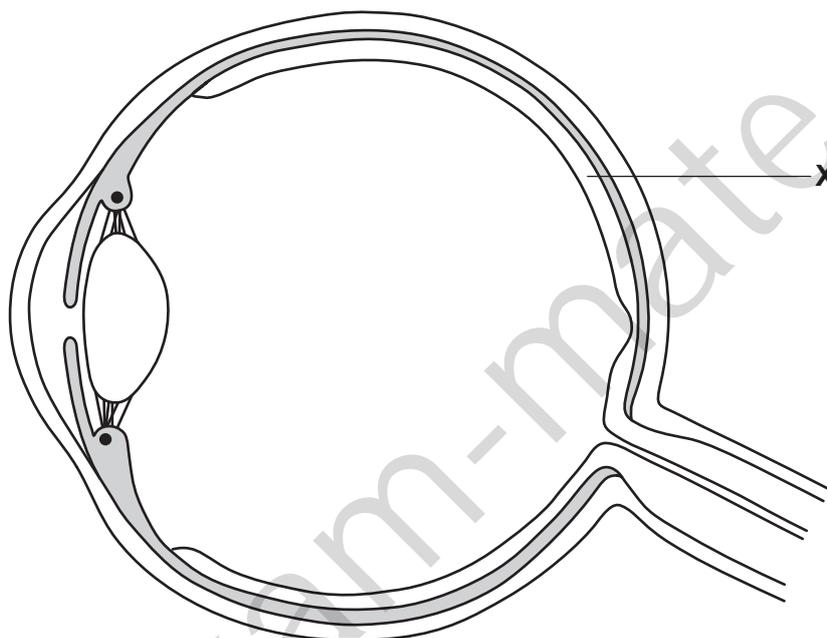


Fig. 9.1

(i) State the name of structure **X** in Fig. 9.1.

..... [1]

(ii) List **three** parts of the eye that light passes through to reach structure **X**.

1
 2
 3 [3]

(iii) Label the optic nerve **on** Fig. 9.1 by drawing a label line and the letter **N**.

[1]

(iv) State the function of the optic nerve.

..... [1]

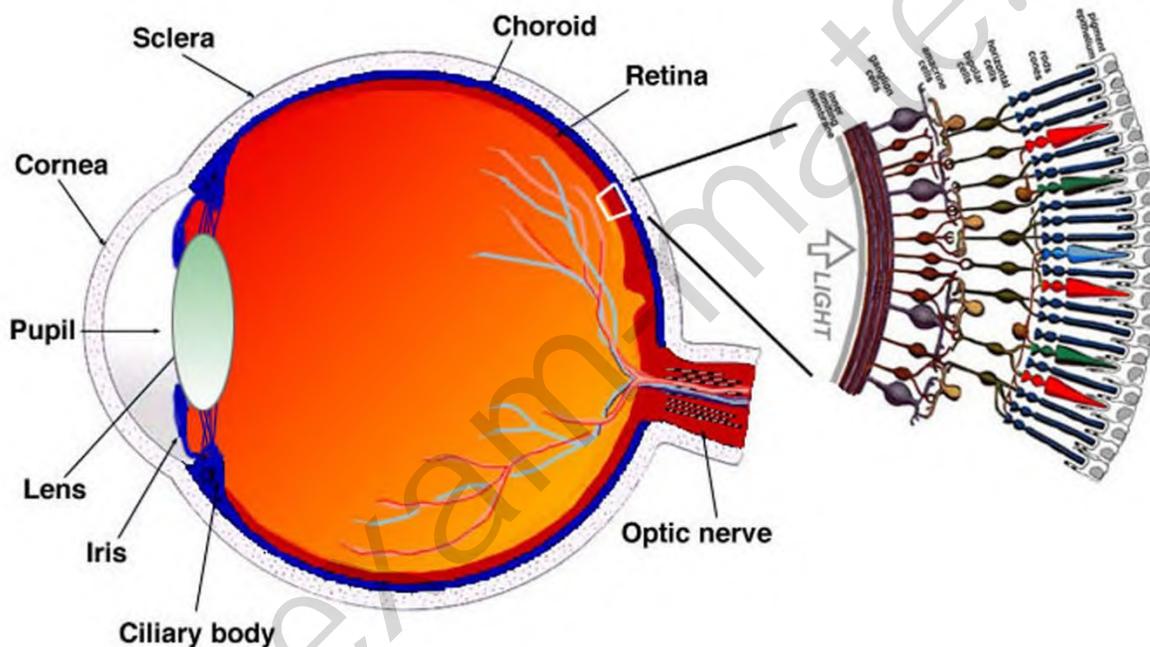
[Total: 8]

Question no. 9

(a) Definition of a sense organ [2 marks]

A **sense organ** is a **group of specialised receptor cells** that **detect and respond to a specific stimulus** in the environment. These receptor cells convert the stimulus into electrical signals that can be transmitted to the nervous system.

(b) Structure and function of the eye



(i) Name of structure X [1 mark]

Structure **X** is the **retina**.

(ii) Three parts that light passes through to reach structure X [3 marks]

Light passes through the following structures (any three):

1. **Cornea** – allows light to enter the eye and begins refraction
2. **Pupil** (controlled by the iris) – regulates the amount of light entering

3. **Lens** – refracts and focuses light
4. **Aqueous or vitreous humour** – maintains shape and allows light transmission

(Any **three** gain full credit.)

(iii) Labelling the optic nerve [1 mark]

The **optic nerve** is the thick bundle leaving the back of the eye. On the diagram above, it should be labelled with a line pointing to this structure and the letter **N**.

(iv) Function of the optic nerve [1 mark]

The **optic nerve transmits electrical impulses from the retina to the brain**, where the impulses are interpreted as visual information.

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